HPC Data Center Overviews: Summit & Frontier

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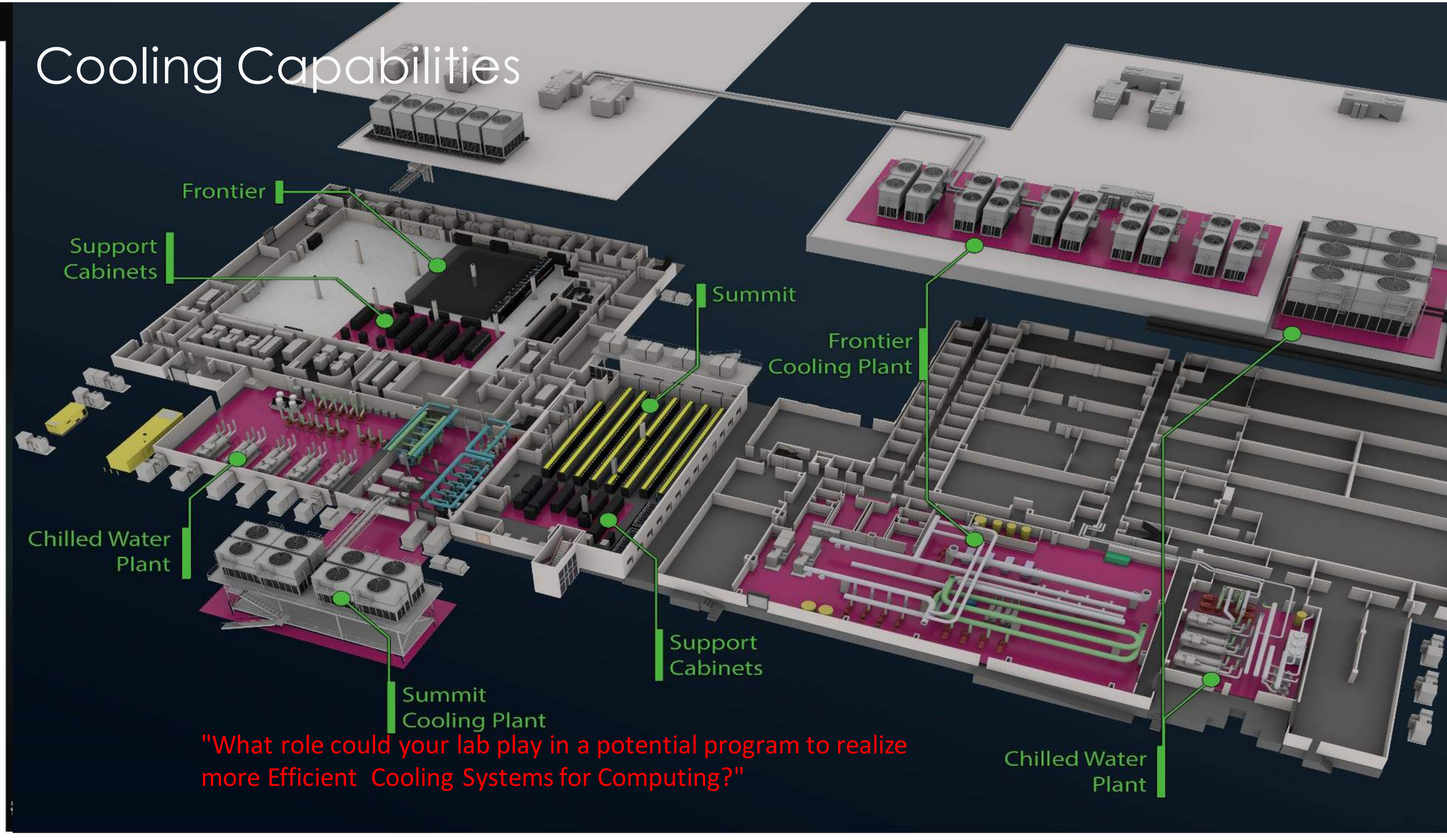
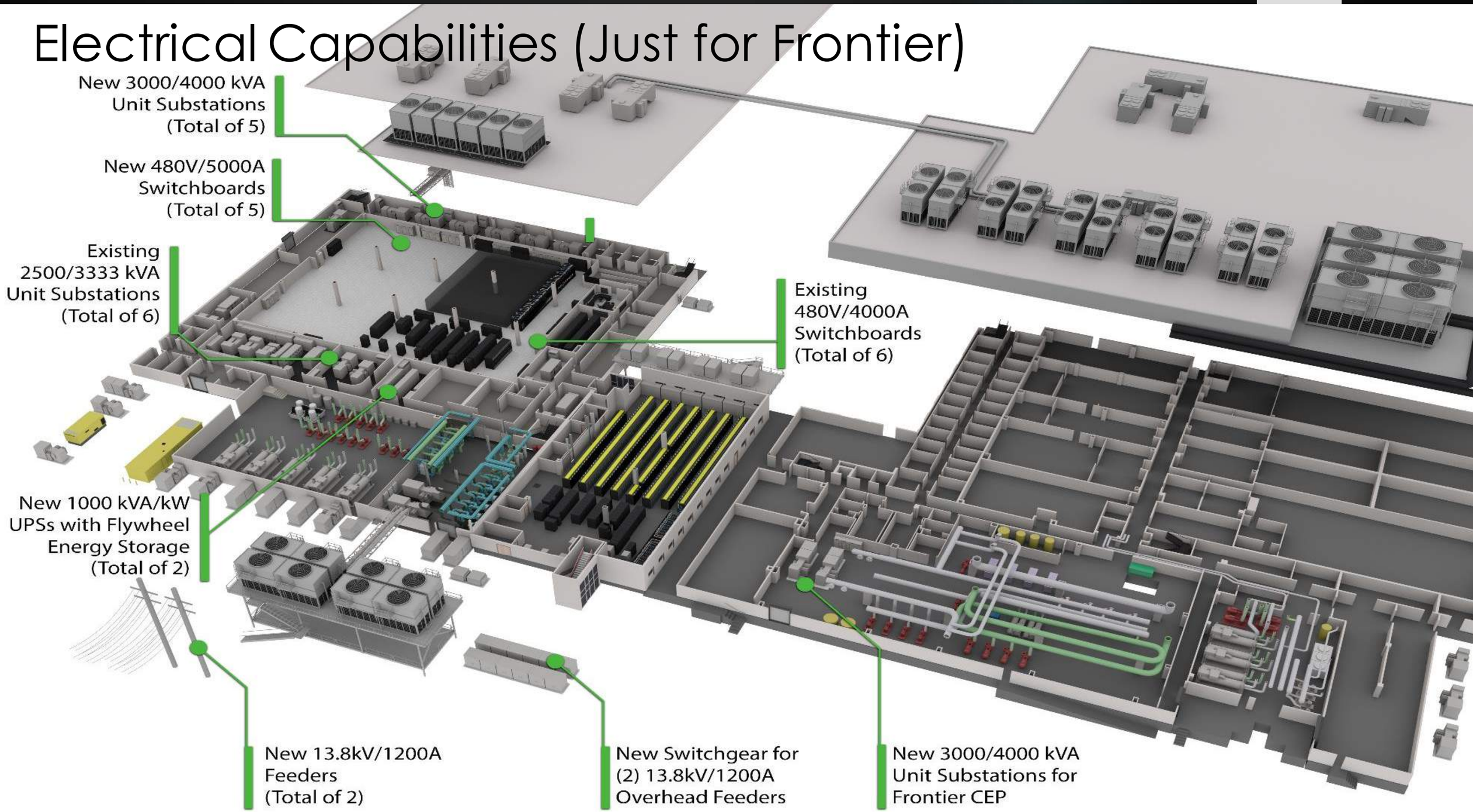
Cooling Capabilities



"What role could your lab play in a potential program to realize more Efficient Cooling Systems for Computing?"

Electrical Capabilities (Just for Frontier)



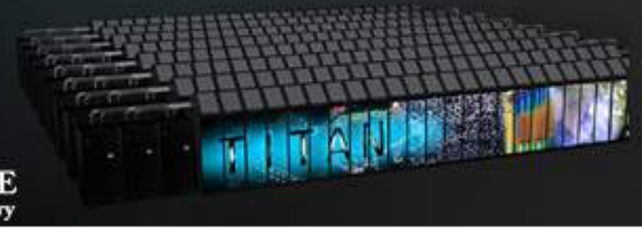
Design Drivers in ORNL's Exascale Facility

Summit/Pre-exascale

- 2018 Substantial Completion
- CPU/GPU case temperatures in 86-89 °C range provides design flexibility
- Heat capture: 75% direct-to-water
- Warm water (70 °F) Supply Temperature with an ability to trim using 42.5 °F CW)
- Facility targets: 20MW / 7700 tons / 3300 gpm / 1.10 annualized PUE

Frontier/Exascale

- 2021 Substantial Completion
- CPU/GPU/DDR4 case temperatures in 86-89 °C range
- Heat capture: > 97% direct-to-water
- ASHRAE W32 water (ORNL has a 29.4 °C / 85 °F nominal target)
- Facility targets: 40MW / 12,000 tons / 16,000 gpm / 1.05 1st yr. annualized PUE



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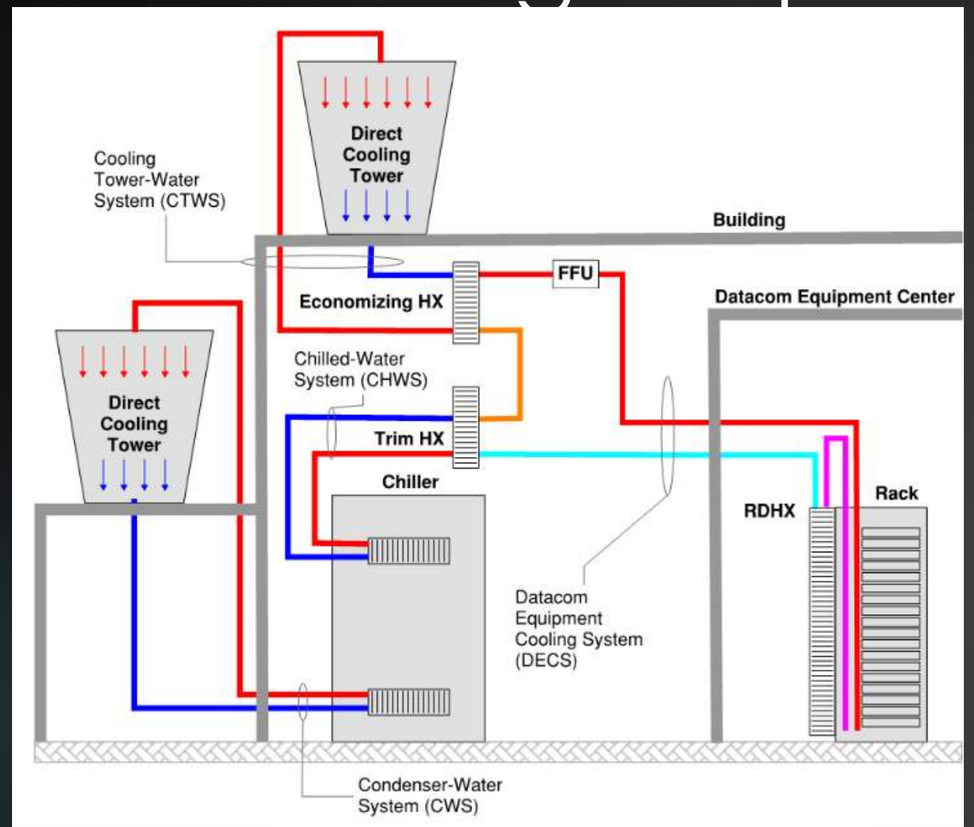
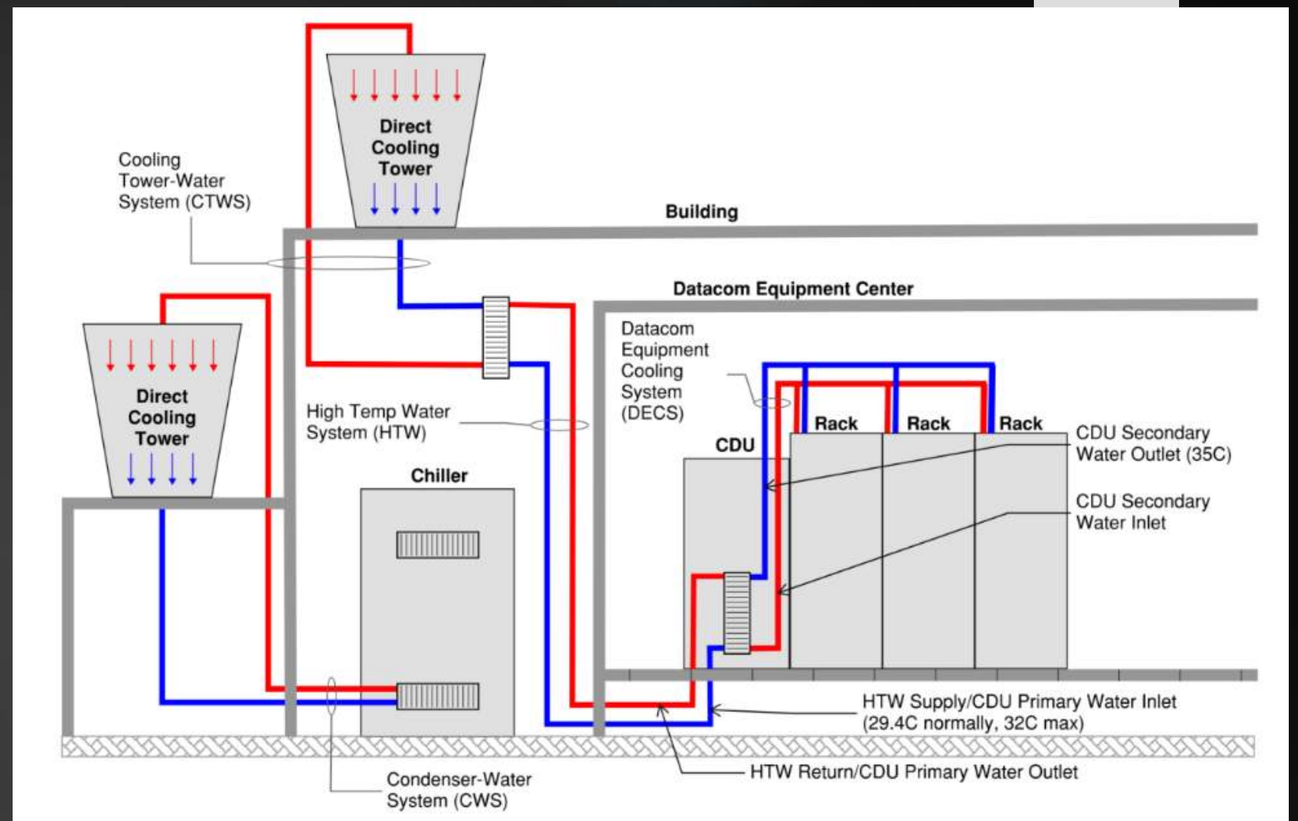
HPC – Cooling Loops

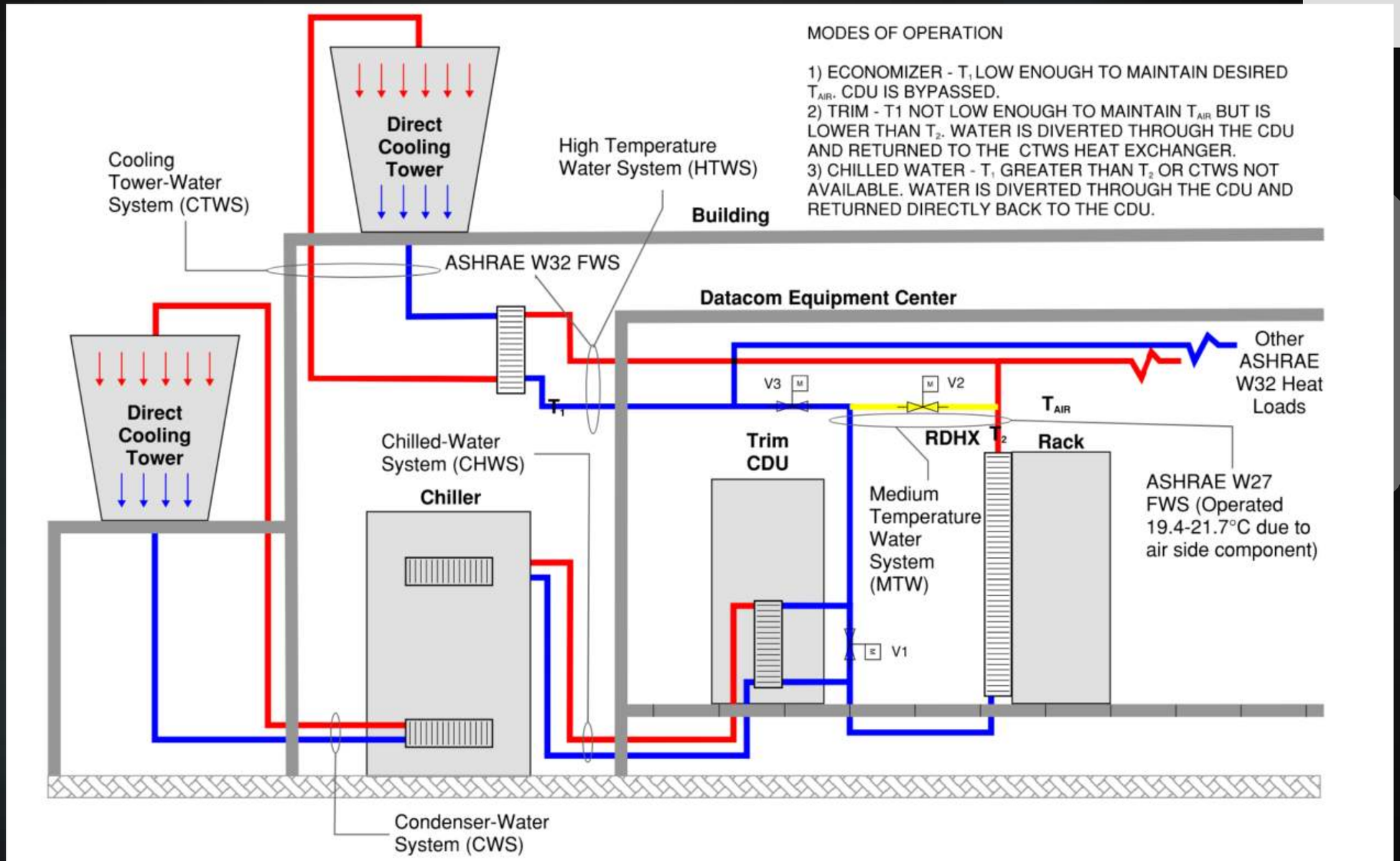




summit

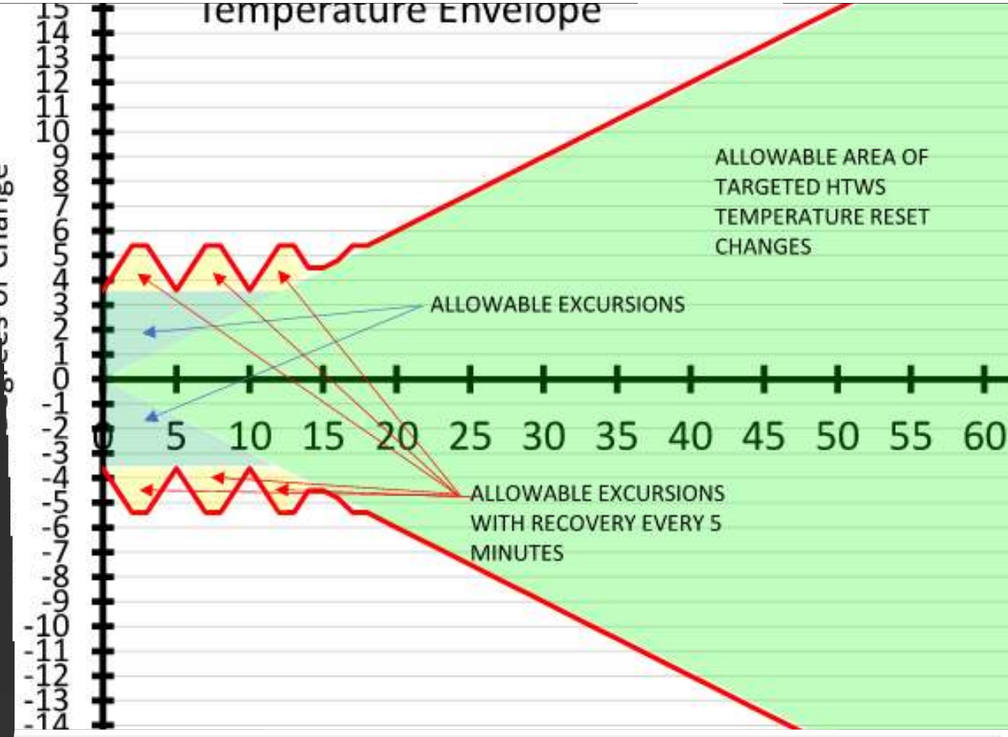
FRONTIER

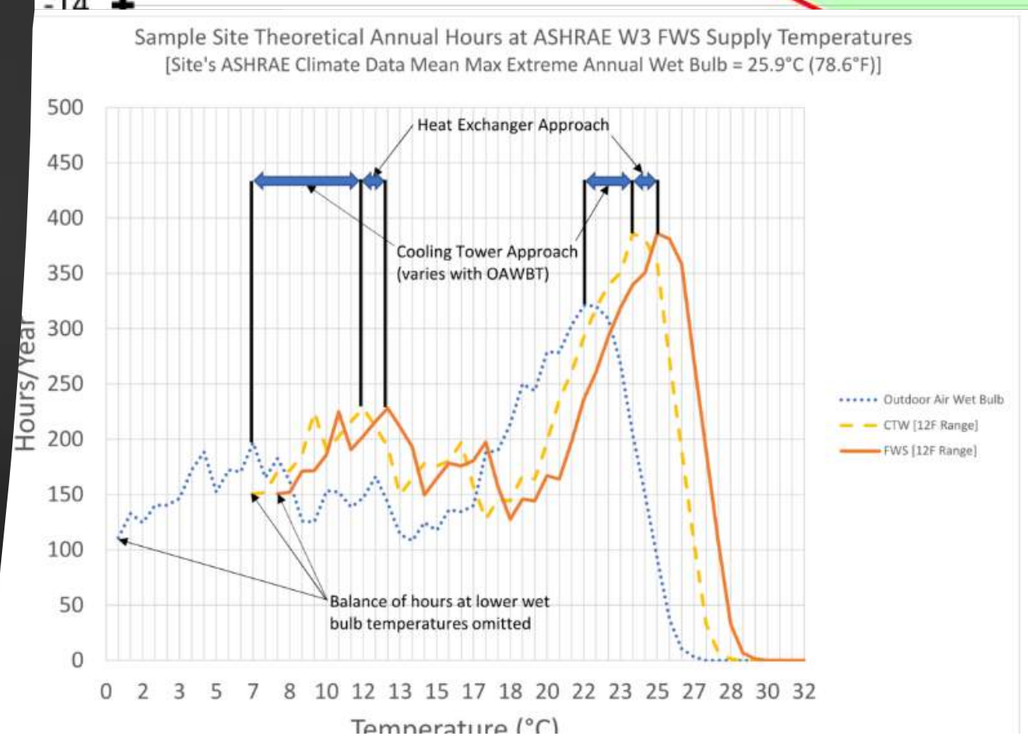
Trim CDU – Rack Densities >13kW



HTW Supply Temperature Stability

- ASHRAE W32 Inlet Water
- 41°F (5 °C) – 89.6 °F (32 °C)
- Desire STABLE inlet temperatures more than a specific temperature
- Stable means we meet the cooling load 1 for 1
- Disruptions from all points in the system
- Staging of cooling towers presents biggest challenge
- No thermal reservoir/buffer outside of the circulating system volume





Controls Strategy

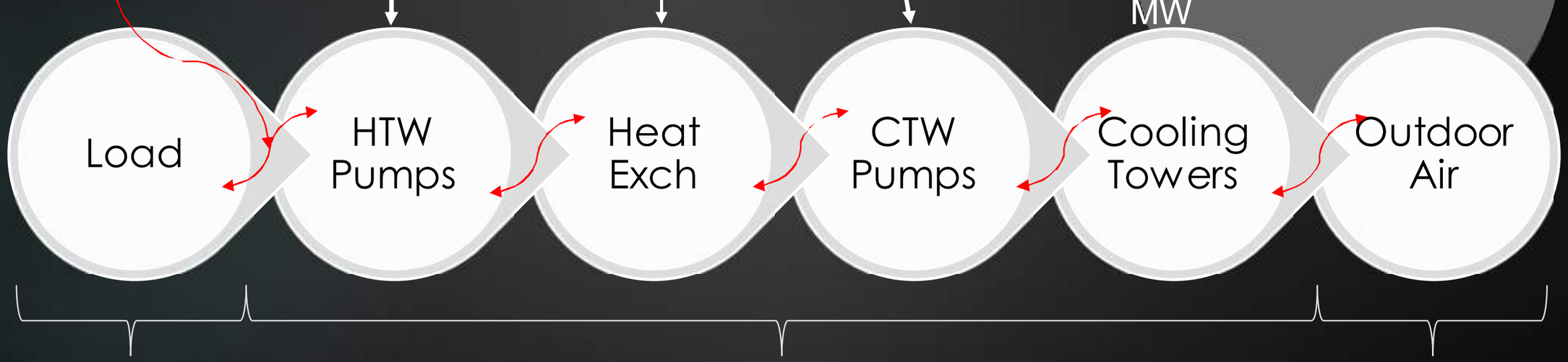
Controls "buffers" to give engineering level optimization tools

HTW pumps controlled on dP to serve the flow requirements of the load

Staging of heat exchangers is balance between minimum flow and surface area

CTW pumps controlled for HTWS Temp Stability bounded by max/min flow on number of towers staged

Staging of cooling towers is based on HTWS Temp stability AND predictive logic to cover load increases greater than X MW



Facility Challenges

"What role could your lab play in a potential program to realize more Efficient Cooling Systems for Computing?"

Systems' Load & Supply Temp

89.6°F (32°C)

71°F (21.7°C)

42°F (5.5°C)

Air-Side Waste Heat

Sys G. (20F dT)

Sys H. (30F dT)

Pumps

Towers

0.2kW/ton

HTW System

HTW CEP

HTW Efficiency

Sys I.

HHTW 5F dT

Sys D. (12F dT)

Sys E. (14F dT)

Sys F. (20F dT)

Pumps

Chillers

Towers

Towers

0.4kW/ton

MTW System

MTW CEP

MTW Efficiency

Pumps

Fans

0.?kW/ton

HTW CEP

HHTW Efficiency

158°F (70°C) ?

Sys A. (12F dT)

Sys B. (14F dT)

Sys C. (20F dT)

Pumps

Chillers

Towers

0.8kW/ton

CHW System

CHW CEP

CHW Efficiency

Air-Side Waste Heat

Efficiency

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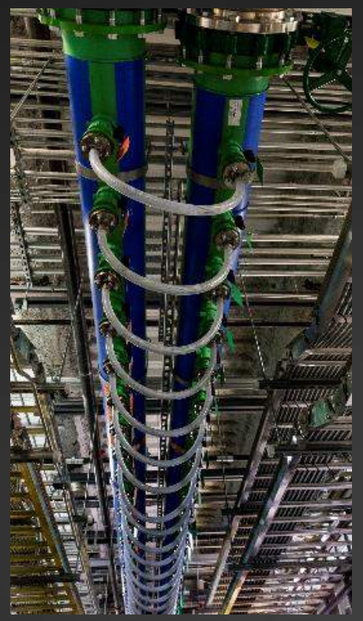
IT Concerns

- Leakage currents/error rates at elevated temperatures
- Reliability of components – rate of depreciation on these systems is already depressing
- How will the form-factor change
- Will computational increase be of such a value that facility enhancements and those costs are justified?

"Our scientific models are able to consume any level of computational capacity that can be made available."

Discussion

https://www.olcf.ornl.gov/summit/
https://my.matterport.com/show/?m=iBfbj7ET4LT



https://www.olcf.ornl.gov/frontier/
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